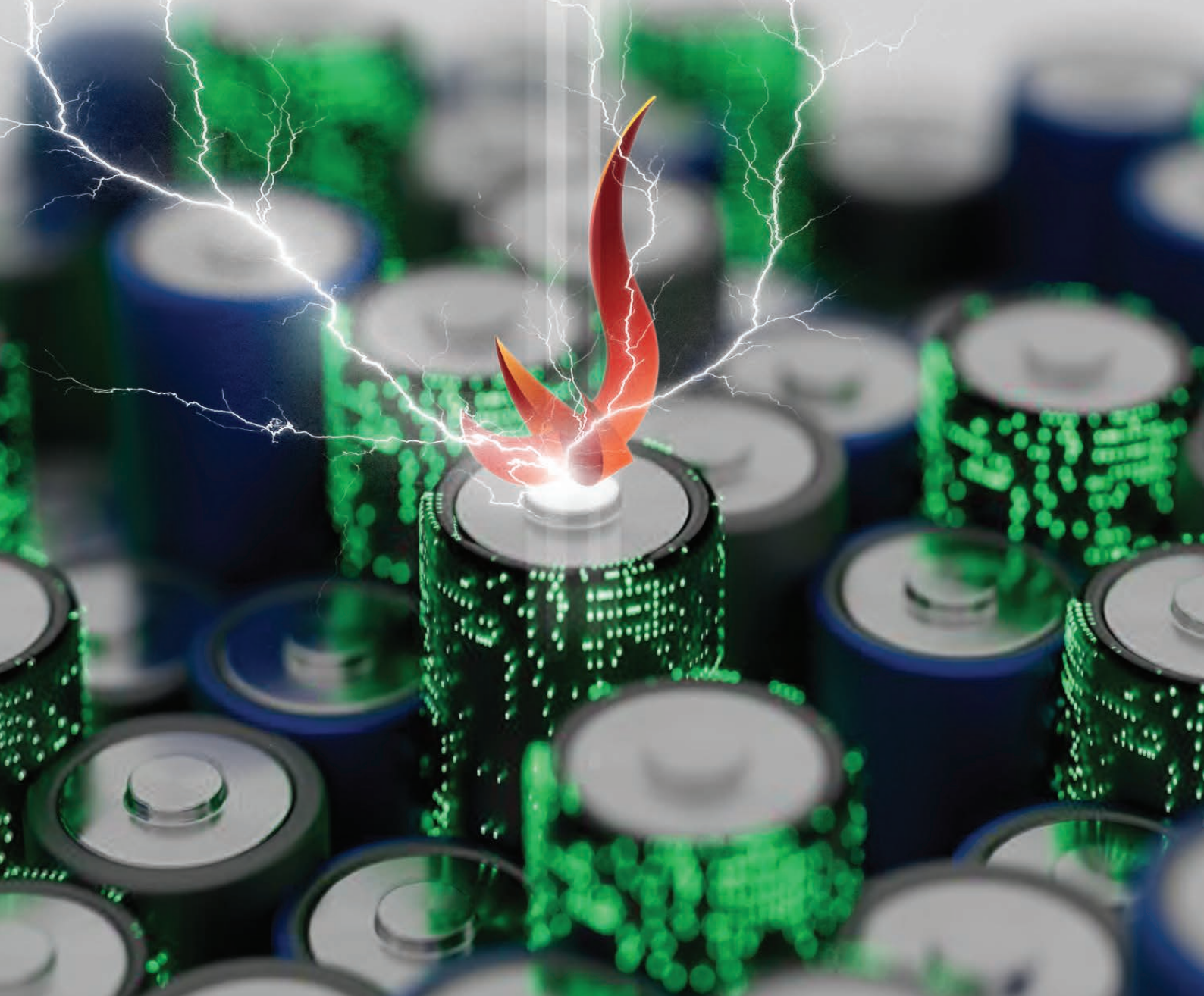
香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

香港科大能源研究院
The HKUST Energy Institute

HKUST ENERGY INSTITUTE NEWSLETTER

NOVEMBER 2022



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Message from the Director

Welcome to the Energy Institute (EI) and learn about the EI's latest accomplishments via our newsletter!

First of all, I would like to express my sincere gratitude to Prof. Tianshou ZHAO, the Founding Director of the EI from 2014 to 2021. Prof. Zhao, an outstanding researcher in energy conversion and storage, has made great contributions to science and technology and to the community. He is a true leader who has set up our undergraduate and postgraduate energy programs and has nurtured our junior faculty. Under his leadership, the EI has made significant achievements in the past seven years. It is my great honor to be his successor to lead this great Institute.

As a university-wide multidisciplinary platform, the EI has brought together HKUST's energy-related research, education and technology development. Members of the Institute have been investigating next-generation solar cells, secondary batteries, fuel cells, hydrogen production and storage, biofuels, energy-efficient technologies for green buildings, as well as energy policy, among others. From basic research, visionary applications to education, EI faculty has been offering alterative solutions. In this issue, we are delighted to feature some of our breakthrough findings on batteries and hydrogen fuel cells.

Congratulations to our members for achieving team-based funding success in the past year. For instance, Prof. Francesco CIUCCI and I received the first batch of the Green Tech Fund; Prof. Jianwei SUN was awarded the Collaborative Research Fund; Prof. Baoling HUANG and Prof. Zhiyong FAN were both awarded large-scale Foshan HKUST Projects; just to name a few. For us to advance further, it is essential to attract more scientists to establish partnerships at multiple levels and to conduct impactful multidisciplinary research. Over the year, we have welcomed 15 new members to join the EI family, thus increasing the total number to 36.

To equip the next generation of energy researchers with theoretical and practical skills and to address global energy challenges, the Institute had initiated in earlier years Hong Kong's first bachelor program in Sustainable Energy Engineering with its first batch of graduates in summer 2021. By supervising independent projects, the EI's faculty also fully supports the new taught postgraduate program in Chemical and Energy Engineering.

Committed to excellence, the Institute aims to be a top-notch hub for multidisciplinary research and education. With our efforts and your support, we aim to make this dream of clean energy a reality together.

Prof Minhua Shao

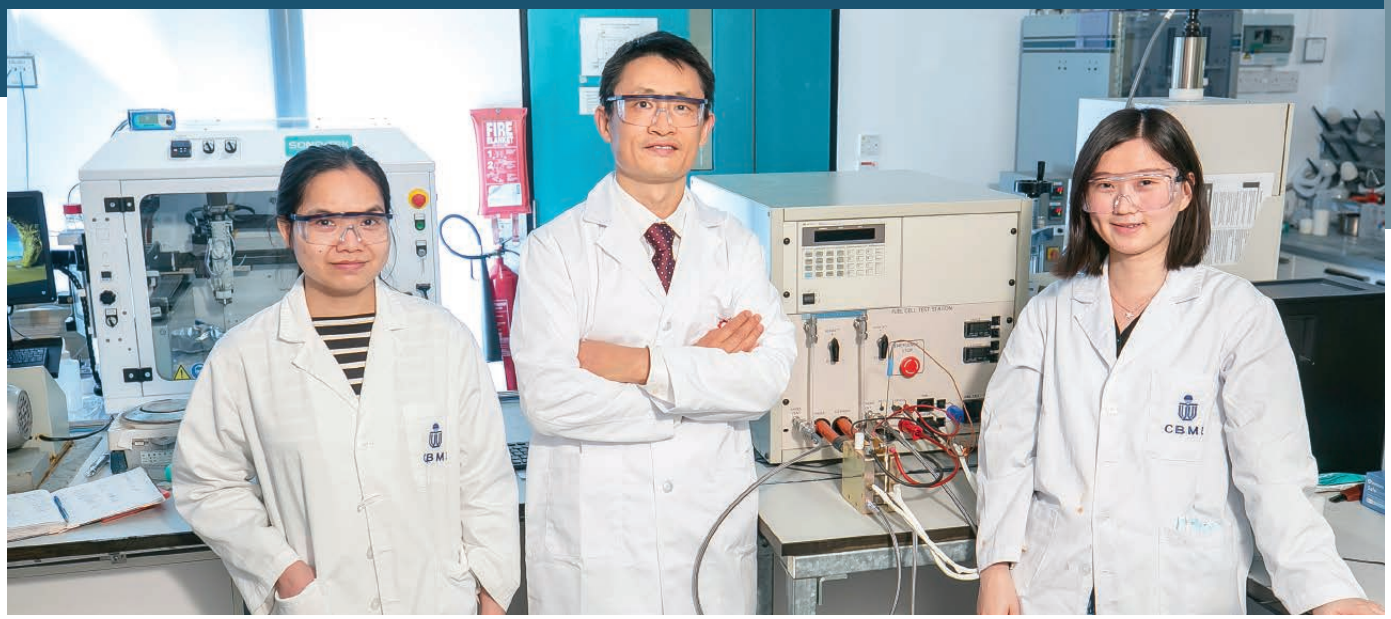
Director of the HKUST Energy Institute

Cheong Ying Chan Professor of Energy Engineering and Environment

Chair Professor of Chemical and Biological Engineering

Prof. Minhua SHAO and Prof. Francesco CIUCCI Together Awarded over HK$12 Million Green Tech Fund

Prof. Shao's project is expected to accelerate the implementation of clean hydrogen technologies in Hong Kong.



Two engineering professors have been awarded the Green Tech Fund with an overall grant of more than HK$12 million. They are Prof. Minhua SHAO, Director of Energy Institute and Chair Professor of Chemical and Biological Engineering, and Prof. Francesco CIUCCI, Associate Professor of Chemical and Biological Engineering as well as Mechanical and Aerospace Engineering.

Prof. Minhua Shao was awarded close to HK$9 million for his project “Development of High Performance and Long Life Hydrogen Fuel Cells Stacks” in the area “Energy saving and efficiency”. In this three-year project, Prof. Shao’s team aims to develop and commercialize the key materials and components of fuel cells, which are low platinum catalysts and membrane electrode assemblies, that will then be integrated into high performance fuel cell stacks. By collaborating with Towngas and other leading industry partners in Hong Kong and Mainland China, the team expects to address the problems of high precious-metal loading in fuel cells, poor performance and low durability, as well as to accelerate the implementation of clean hydrogen technologies in Hong Kong.

The project on “Green Hydrogen Production from Active Flow Membraneless Electrolyzers”, led by Prof. Francesco Ciucci, was awarded around HK$3.2 million for a period of three years. The goal of this project is to develop an innovative electrolyzer to produce green hydrogen at a cost significantly below that of conventional electrolyzers. The project will allow the scale-up of the current prototype stack and demonstrate that it is cost-competitive against CO_2-emitting grey hydrogen.

The HK$200 million Green Tech Fund was set up by the Hong Kong government in 2020 to provide better and more focused funding support for research and development projects which can help Hong Kong decarbonize and enhance environmental protection as Hong Kong strives towards carbon neutrality by 2050. The Fund received an overwhelming response of over 190 applications in the first round of applications.

Prof. Ciucci’s project aims to scale-up the current prototype stack and to demonstrate that it is cost-competitive against CO_2-emitting grey hydrogen.

Prof. Jianwei SUN
Awarded Collaborative Research Fund

Prof. Jianwei SUN, Professor of Chemistry, has been awarded over HK$ 6M by the Collaborative Research Fund (CRF) to carry out a multidisciplinary research on “Development of a New Generation of Privileged Chiral Catalysts for Asymmetric Synthesis”.

In this three-year project, Prof. Sun and his team aim to develop a new generation of privileged chiral catalysts for asymmetric synthesis. The new chiral catalysts will also be applied to harness clean energy for organic synthesis and catalyze fixation and conversion of greenhouse gas. The large conjugation system combined with the chirality feature of the structures, for instance, endows the structures with great potential to serve as photosensitizers for photochemical asymmetric reactions. They are also potential catalysts for direct conversion of CO_2 to synthesize value-added chiral functional materials. The new catalysts are expected to find long-term applications in academic laboratories and various industries.

Collaborating with the University of Hong Kong, this project is the joint effort of four research laboratories with complementary expertise in organocatalysis, metal catalysis, computation, and industrial synthesis.

The Collaborative Research Fund is one of the most competitive research grants in Hong Kong. Administered by the Research Grants Council (RGC), the Fund aims at encouraging research groups in universities funded by the University Grants Committee to engage in collaborative research across disciplines and universities with a view to enhancing the research output in terms of the level of attainment, quantity, dimensions and speed.

Prof. Baoling HUANG and Prof. Zhiyong FAN Together Awarded RMB 4.9 Million by Foshan HKUST Projects

Two HKUST engineering professors have been awarded an overall grant of RMB 4.9 million by Foshan HKUST Projects. They are Prof. Baoling HUANG, Professor of Mechanical and Aerospace Engineering and Prof. Zhiyong FAN, Professor of Electronic and Computer Engineering as well as Chemical and Biological Engineering.

Prof. Huang was awarded RMB 2.8 million for his project "The Development and Integration of High-safety Smart Aqueous Lithium-ion Battery with High-rate Performance". In this two-year project, Prof. Huang's team aims to develop a new type of high-safety smart aqueous lithium-ion secondary battery based on environmentally-friendly thermal responsive hydrogel. This flexible aqueous battery can provide fast-charging as well as self-protection capabilities under high temperatures. Its design considers the impact of lithium salts on the thermally-responsive hydrogel and the performance of battery. It adopts high-concentration 1 M $LiNO_3$ solution as the electrolyte, which can maintain the smart thermal responsive behavior of the hydrogel while providing stable charging/discharging performance. The thermal switching temperature can be tuned by modifying the concentration of hydrophilic functional groups in the hydrogel, thus providing great adaptability to different application scenarios. The new battery is expected to be a promising energy storage technology for wearable electronics.

Prof. Fan was awarded RMB 2.1 million for the project "Research of Flexible and Wearable Intelligent Environment Sensing System". In this project, Prof. Fan's team aims to develop a new generation of flexible and wearable environment sensing system for special industries. It adopts advanced intelligent sensing technology to monitor, feedback, warn accurately and in real time the working environment parameters such as temperature, humidity and related harmful gas concentration around operators. By so doing, it aims to reduce the risk of accidents and play a comprehensive role in safeguarding the life of special operators. The wearable detection equipment developed features fast detection speed, high accuracy, multiple gas detection, high safety factor, strong anti-interference capability, excellent dust proofness, small size, flexibility and light weight etc. It is ideal for on-site leak detection and mobile use, which can provide real-time insight of the status and safety of operators in hazardous areas and help on-site operators and companies respond to safety accidents in a more scientific and decisive manner.


Prof. Zhiyong Fan


Prof. Baoling Huang

More importantly, Prof. Fan's project on environment sensing system will be perfectly integrated with Prof. Huang's project on high-safety water-based battery. The joint efforts aim to ultimately achieve safe and reliable environmental sensing under harsh conditions.

Funded by the Foshan Government, the University-Enterprise Collaborative R&D Program under Foshan HKUST Projects supports substantive R&D cooperation among HKUST and its mainland platforms and enterprises in Foshan. It focuses on R&D, application of technology, and exploration of effective mechanisms for technology collaboration. With Foshan's manufacturing technologies and innovative achievements in industrialization, the R&D Program further boosts the city's industrial transformation and development.

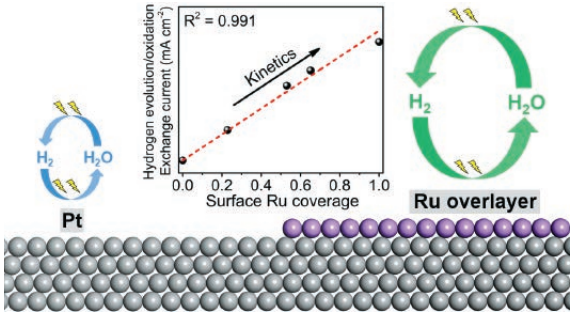
HKUST Scientists Discover New Mechanisms of Activity Improvement on Bimetallic Catalysts for Hydrogen Generation and Fuel Cells

An HKUST research team led by Energy Institute Director Prof. Minhua SHAO and partners at Xiamen University has revealed new understandings of how surface ruthenium atoms can improve the hydrogen evolution and oxidation activities of platinum. This discovery opens a new venue for rational design of more advanced catalysts for electrolyzer and fuel cell applications.

As a clean energy carrier that does not contain carbon, hydrogen is believed to play an essential role in achieving sustainable society. Hydrogen can be produced from water via the hydrogen evolution reaction (HER) in an electrolyzer by using renewable energies, and consumed via a hydrogen oxidation reaction (HOR) in a fuel cell to generate electricity. Unfortunately, these two reactions are known to be kinetically sluggish in alkaline media and even on the most active platinum catalysts. Slow reaction rates limit the efficiencies of these two electrochemical devices and hinder their wide adoption. Whereas the reaction rates of HER/HOR on platinum can be improved by surface modification or alloying with ruthenium, the mechanisms for this improvement have been under debate for decades, partly due to lack of direct observation of behaviors of hydrogen atoms on the surfaces of catalysts.

To reveal the enigma of high HER/HOR activities on platinum-ruthenium bimetallic catalysts, a research team led by Prof. Minhua Shao, Department of Chemical and Biological Engineering as well as Energy Institute at HKUST, recently applied the powerful surface-enhanced infrared absorption spectroscopy (SEIRAS) to directly monitor the binding strength of the important reaction intermediate, hydrogen atoms on various surfaces. Through the combined electrochemical, spectroscopic, and theoretical studies they confirmed that the surface ruthenium atoms interacted with the sub-surface platinum and they are one order of magnitude more active than platinum, i.e., the ruthenium rather than platinum atoms are main active sites in this system.

"Previous projects mainly used conventional electrochemical and characterization techniques,



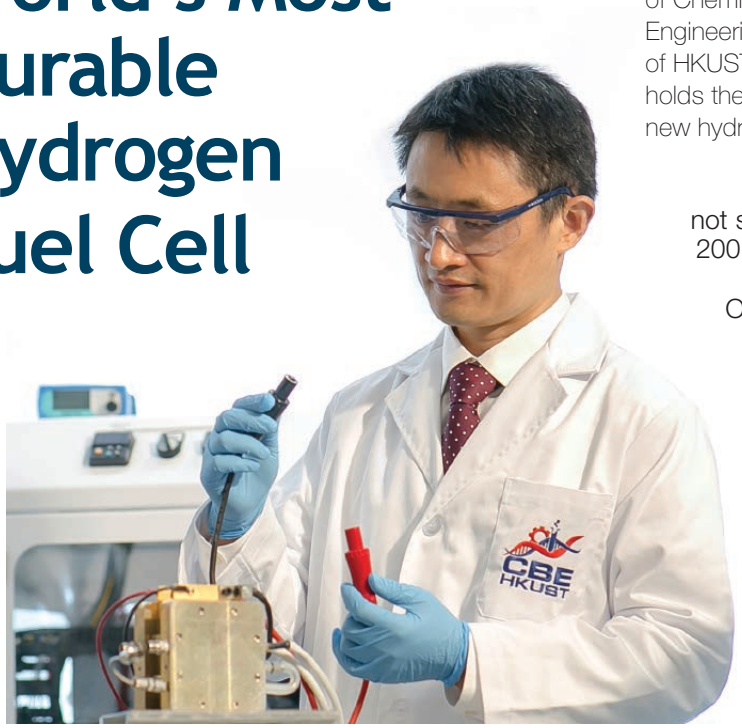
Ruthenium atoms supported on platinum are extremely active to produce hydrogen.

which cannot directly monitor the adsorption behavior of hydrogen reaction intermediates. In this project, we use the powerful surface-enhanced infrared absorption spectroscopy, which is among the very few techniques that can directly 'see' surface hydrogen atoms, and which provides us with more straightforward information on how ruthenium improves the activity," said Prof. Shao. "This project rules out the most widespread theory that the bifunctional effect on the interface between platinum and ruthenium is the cause of increased activities. It opens up new directions on future design of more advanced HER/HOR catalysts, which can ultimately reduce the usage of precious metals in both water electrolyzers and hydrogen fuel cells."

As part of Prof. Shao's new project on "Development of High-performance and Long-life Alkaline Membrane Fuel Cells" under Collaborative Research Fund, this recent work constitutes an important subsection of fundamental research to the entire project. Subsequent projects on the development of practical and high-performance bimetallic platinum-ruthenium electrocatalysts, based on these findings, are in progress.

The study has recently been published in *Nature Catalysis* with the title "The Role of Ruthenium in Improving the Kinetics of Hydrogen Oxidation and Evolution Reactions of Platinum".

HKUST Develops World's Most Durable Hydrogen Fuel Cell



Prof. Minhua Shao, Professor from HKUST's Department of Chemical and Biological Engineering and the Director of HKUST Energy Institute, holds the prototype of the new hydrogen fuel cell.

A research team led by Prof. Minhua SHAO, Director of HKUST Energy Institute and Chair Professor of Chemical and Biological Engineering, has developed a new hydrogen fuel cell which is not only the world's most durable[1] to date, but also more cost-effective. It paves the way for a wider application of green energy in the pursuit of a carbon neutral world.

Hydrogen fuel cell is a promising option for clean energy as it generates power by converting hydrogen and oxygen into electricity with zero emission of carbon dioxide, particulate matters and other air pollutants that may cause smog or health problems. Despite its environmental benefits and years of development, hydrogen fuel cell nevertheless has not been widely commercialized. That is because its power generation depends heavily on an electrocatalyst which is largely made up of expensive and rare metal platinum.

Scientists have strived to develop alternatives by replacing platinum with more common and inexpensive materials such as iron-nitrogen-carbon. However, those materials are either proven inefficient in power generation or have poor durability.

Now, Prof. Shao's research team has found a new formula which not only could cut down the proportion of platinum use by 80 percent, but also set a record in terms of the cell's durability level.

Despite the low proportion of platinum, the new hybrid catalyst developed by the team managed to maintain platinum catalytic activity at 97% after 100,000 cycles[2] of accelerated stress test, compared to the current catalyst which normally sees a drop of over 50% in performance after 30,000 cycles. In another test, the new fuel cell did not show any performance decay after operating for 200 hours[3].

One reason behind such outstanding performance is the fact that the new catalyst has three different active sites for the reaction, instead of just one for current catalysts. Using a formula containing atomically dispersed platinum, iron single atoms and platinum-iron nanoparticles, the new mix accelerates reaction rate and achieves a catalytic activity 3.7 times higher than that of the platinum itself. Theoretically, the higher the catalytic activity, the greater the power it delivers.

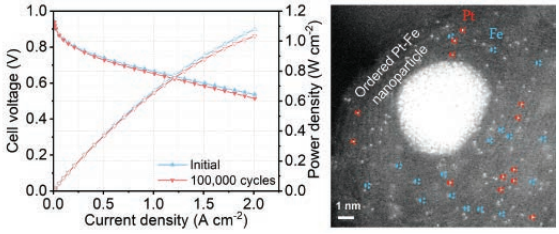
Prof. Shao stated, "Hydrogen fuel cell is an energy conversion device essential for our aspiration of achieving a carbon neutral world. There is a need to expand its use amidst our fight against climate change, and we are delighted to see our research findings bringing us one step closer to achieving this goal. Thanks to the HKSAR Government's Green Tech Fund, we will seek to further refine the catalyst and make it compatible with fuel cell vehicles and other electrochemical devices."

The study is financially supported by National Key R&D Program of China, Shenzhen Science and Technology Innovation Commission, and the Research Grant Council of the Hong Kong Special Administrative Region. The research findings have recently been published in the journal *Nature Catalysis*.

1 According to the test protocols of US Department of Energy in assessing the durability of fuel cell

2 One cycle is equivalent to 3 seconds with voltage level at 0.6V, followed by another 3 seconds with voltage level at 0.9V

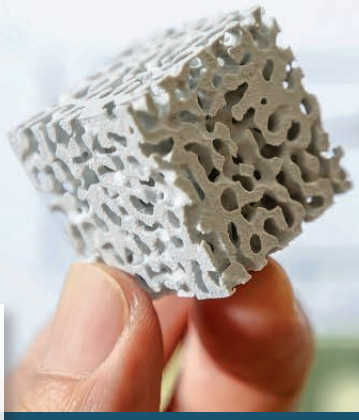
3 The voltage level is set at 0.6V



(Left) The new hybrid catalyst maintains the platinum catalytic activity at 97% after 100,000 cycles of accelerated stress test; (Right) The new electrocatalyst contains atomically dispersed platinum, iron single atoms and platinum-iron nanoparticles.

Prof. Qing CHEN's Group Developed Nanoporous Zinc Electrodes that Make Primary Alkaline Zinc Batteries Rechargeable

(From left) Prof. Qing Chen and his research group members Dr. Liangyu Li (postdoctoral fellow) and Diwen Xiao (PhD student) at the lab of HKUST Energy Institute. On the lab bench is a set-up for fabricating the nanoporous zinc metal electrode.



A 3D model of the nanoporous structure in the zinc electrode, magnified by 10,000 times for visualization.

A research team led by faculty of the Energy Institute Prof. Qing CHEN, Associate Professor of Mechanical and Aerospace Engineering as well as Chemistry, has developed a new electrode design that is set to enable the rechargeability of alkaline zinc batteries, one of the most common types of non-rechargeable batteries used in our daily lives. The research breakthrough sheds light on a wider application of rechargeable batteries.

Batteries are important in the age of smart cities and global digitalization. The majority of batteries in the market however, known as primary batteries, are not rechargeable. Disposed after a single use, the unsustainable practice poses a serious threat to the environment.

Compared with other types of primary batteries, alkaline zinc batteries are cheap, safe, and energy-dense. They are used in many household items such as flashlights and remote controllers. Given the advantages, there is never a lack of effort from researchers worldwide trying to make alkaline zinc batteries rechargeable.

Such efforts have nevertheless been falling short because the battery reaction of zinc is hardly reversible. When the battery is discharged, zinc particles in the zinc electrode are covered with a thick and non-uniform layer of insulating zinc oxide, losing the metal surface and electric conductivity which are both necessary for the electrode to be recharged.

To tackle the issue, Prof. Chen's research team developed a nanoporous zinc metal electrode that is capable of stabilizing the electrochemical transition between zinc and zinc oxide. They successfully turned an alkaline zinc-air coin cell, a type of primary battery usually found in hearing aids, into a rechargeable battery stable for over 80 hours. The team shaped zinc into curvy filaments hundreds of nanometers wide, nested in a freestanding solid with numerous, similarly narrow pores. When the battery is discharged, a thin layer of zinc oxide nucleates on the zinc filaments, preserving the metallic network and enabling the zinc electrode to return to its initial structure.

The team also tested out the nanoporous zinc electrode in alkaline nickel-zinc batteries, a kind of uncommon secondary zinc battery which normally offers 50-80 times of discharging and charging under a condition competitive against the state-of-the-art lithium-ion batteries. The result demonstrated a multi-fold increase to over 200 times.

"The needs for batteries are diverse and difficult to be met by a single technology. Zinc batteries are finding their niche. We just need to make sure that the microstructure of the zinc electrodes can withstand hundreds, and hopefully thousands of times of discharging and charging when getting the most energy out of the batteries," said Prof. Chen. "Our work achieves this by understanding and then designing how atoms organize themselves at the liquid-solid interface that is manifested by the nanoporous structure, which has been applied to address a range of technological challenges," he explained.

Prof. Chen added that while a few hundred times of discharging and charging may not seem many, alkaline zinc batteries boast the advantages of being safe and having low cost which are ideal for industrial applications including golf carts and forklifts. They also suit emerging applications such as the backup power of data centers, which do not demand many times of discharging and charging but require the battery to be extremely safe.

Prof. Chen's group, working with industrial partners since the beginning of the research in 2018, will continue engaging the partners for commercialization of the promising technologies. The team's research work has recently been published in *Nature Communications*.

Led by Prof. Chen, the team included postdoctoral fellow Dr. Liangyu LI, former research assistant Anson Yung-Chak TSANG, PhD student Diwen XIAO, former postdoctoral fellow Dr. Guoyin ZHU, as well as Prof. Chunyi ZHI from the City University of Hong Kong.

HKUST Researchers Developed a Photo-rechargeable Lead-free Perovskite Lithium-ion Battery that Generates Energy and Stores Battery on a Single Device

A research team led by Prof. Jonathan Eugene Halpert, Assistant Professor from the Department of Chemistry at HKUST, develops an inexpensive, lightweight, and lead-free photo-battery that has dual functions in harvesting solar energy and storing energy on a single device.

A team led by Prof. Jonathan Eugene HALPERT, Assistant Professor from the Department of Chemistry, has developed an inexpensive, lightweight, non-toxic, lead-free photo-battery that has dual functions in harvesting solar energy and storing energy on a single device. The invention makes it possible to charge a battery under the sun, without having to plug the device into the wall.

The increasing demand for sustainable energy sources has driven a surge of interest in solar energy and developing storage devices for solar energy. One such device, the photo-battery, is capable of both generating and storing energy in a single device architecture. In theory, this design should permit increased energy storage efficiency and energy density, while decreasing ohmic losses, relaxing packaging requirements and thus reducing the weight, bulk, and cost of the system. In reality however, the poor interface between materials tends to create problems with charge transport, greatly reducing the efficiency in comparison with the simple system of a solar cell wired to an external battery.

Prof. Halpert's team has made advancements towards developing more efficient photobatteries by expanding the utility of a class of materials known as perovskite, which has had applications in solar cells and most recently in batteries. The perovskite halide the team developed acts as a photoelectrode that can harvest energy under illumination without the assistance of an external load in a lithium-ion battery. Contrary to existing counterparts, it does not contain lead and thus has higher stability in the air and is free from the concerns of lead poisoning. For the research, the team has replaced lead with bismuth (Bi) which is a non-toxic element, forming a strongly light-absorbing crystalline material.

The lithium-ion battery works by allowing electrons to move from a high energy state to a lower one, while doing work in an external circuit. The photobattery has a mechanism similar to an ordinary battery except that it does not need to be supplied with currents or plugged into the wall to be charged electrically. Rather, it can be charged photoelectrically under the sun. The active material in this new battery is the lead-free perovskite which, when put under light, absorbs a photon and generates a pair of charges known as an electron and a hole. The team conducted chrono-amperometry experiments under light and in the dark to analyze the increase in charging current caused by the light. They recorded a photo-conversion efficiency rate of 0.428% on photocharging the battery after the first discharge. In future, the next step is to experiment with different materials for better performance and efficiency, so that the photobattery can be commercialized in the market.

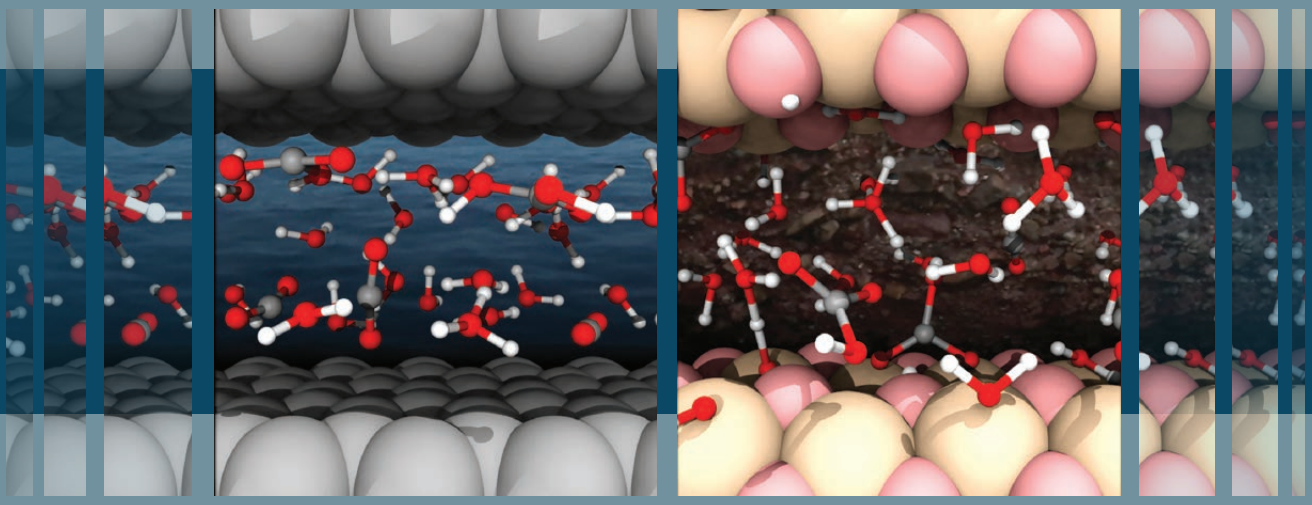
A photograph showing a photocharged $Cs_3Bi_2I_9$ perovskite photo-battery powering a 1.8 V red LED

"At present, we plug all our appliances into the wall to charge them. With further development in this field of photobatteries, we might not have to plug them at all in the future," said Prof. Halpert. "We might be able to harvest solar energy and use it to fulfil the power requirements of any devices with modest power needs. Our work is one of the initial steps taken in this field. A lot of improvements will certainly be needed to achieve better performance. We are nevertheless confident that we can improve its stability and average efficiency with further refinement."

This photobattery can serve as the built-in battery for devices such as smartphones or tablets, and even remote energy storage applications which can be made easy as these photobatteries are lightweight and portable. It should also help lower production cost when compared to a system consisting of a solar cell plus an external battery, since now only the battery part is required.

This study has recently been published in the scientific journal *Nano Letters* on June 16, 2021.

Sparkling Water under Nanoconfinement



A research team led by faculty of the Energy Institute Prof. Ding PAN, Associate Professor of Physics and Chemistry, gave tips to unveil the mysteries of carbon-bearing fluids in Deep Earth.

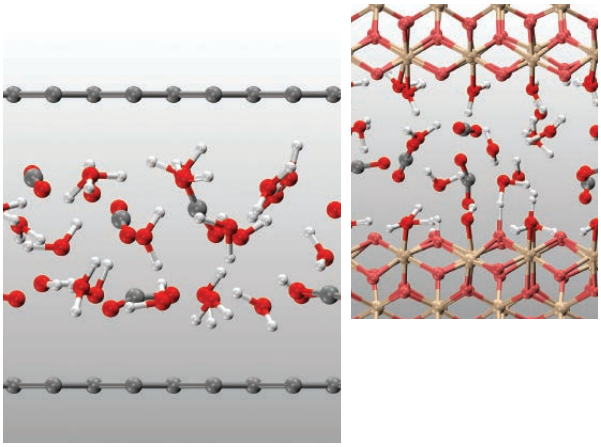
Whereas dissolving CO_2 in water is an everyday process, its ubiquity belies its importance. This has great implications for the Earth's carbon cycle, which deeply affects global climate change and sustainable development of the human society. In carbon capture and storage efforts, turning CO_2 together with water into rocks offers a secure method to permanently store carbon underground with a low risk of return to the atmosphere.

Previous studies focus more on properties of dissolved carbon in bulk solutions. However, in Deep Earth or underground carbon storage, aqueous solutions are often confined to the nanoscale in pores, grain boundaries, and fractures of the Earth's materials, where spatial confinement and interface chemistry may make the solutions fundamentally different.

Prof. Ding PAN and his PhD students, Nore STOLTE and Rui HOU, applied long-time ab initio molecular dynamics simulations to study the CO_2 reactions in water. Their simulations, based on first principles in physics, do not require any experimental or empirical input. The results can be used to guide subsequent experiments. The team compared the carbon solutions nanoconfined by graphene, an atomic layer of graphite, and stishovite, a high pressure SiO_2 crystal, with the bulk solutions. The graphene layer is hydrophobic, while the stishovite surface is hydrophilic. They found that CO_2 reacts more in nanoconfinement than in bulk. The stishovite-water interface makes the solutions more acidic, which may hinder the reactions of CO_2.

Their research suggests that CO_2 may be more active than previously thought in the Earth's deep carbon cycle, which greatly influences the carbon budget in the Earth's near-surface reservoirs. Confining CO_2 and water in suitable nanoporous minerals may enhance the efficiency of underground carbon storage. This study provides a fundamental step towards unveiling the mysteries of carbon bearing fluids in the Earth's interior. The team's work "Nanoconfinement Facilitates Reactions of Carbon Dioxide in Supercritical Water" has recently been published in *Nature Communications*.

Prof. Ding Pan is jointly appointed by HKUST's Department of Physics and Department of Chemistry. His Angstrom group (http://angstrom.ust.hk/) develops and applies high-performance first principles and machine learning methods to seek answers to the urgent and fundamental scientific questions relevant to sustainable development such as water science, deep carbon cycle, and clean energy.



Education

The Energy Institute supports university-level, interdisciplinary energy programs to equip next-generation energy researchers with theoretical and practical skills to address global energy challenges. The Institute has developed Hong Kong's first undergraduate program in Sustainable Energy Engineering, with the inaugural cohort graduating in summer 2021.

Master of Science program in Chemical and Energy Engineering (CEE)

Amidst the increasing importance of environment sustainability, and energy conservation regime in particular, the Energy Institute fully supports the new Master of Science in Chemical and Energy Engineering (CEE), a taught postgraduate program nourishing the next generation to become future energy engineers.

What is CEE?

The program is designed for students who wish to acquire an in-depth understanding of a particular area in chemical and energy engineering while strengthening their overall knowledge at an advanced level.

What will you learn from the CEE program?

The unique program provides students with updated knowledge on product development, material sciences, energy conversion and utilization, renewable energies, power generation, carbon neutrality, and sustainable development. It covers knowledge in the areas of energy, environment and nanotechnology, which are the three focal areas of HKUST.

Not only does the program offer advanced chemical and energy engineering courses for students. It also enables these future chemical and energy engineers to take electives from other related programs to prepare them for leadership and senior positions.

Career Prospect

Upon completion of this program, graduates could further pursue postgraduate studies or work in chemical firms, electric vehicle manufacturers, renewable energy companies and so on.

Curriculum

Foundation Courses

- Theory and Practice in Heterogeneous Catalysis
- Power Generation Technologies
- Decarbonization Technologies
- Energy, Environment and Sustainable Development
- Electrochemical Energy Technologies
- Process Reactor Selection and Design

Elective Courses

- Advanced Separation Processes
- Polymer and Materials Characterization Techniques
- Process Safety Management and Risk Analysis
- Energy Integration and Optimization for Process Industry
- Chemical Product Engineering
- Independent Project

Special Topics

- Advanced Control and Data Science
- Energy Policy

Find out more: https://seng.hkust.edu.hk/msc/cee

Bachelor of Engineering in Sustainable Energy Engineering (SUSEE)

What is SUSEE?

Energy issues are among the most substantial and difficult challenges that humankind faces today. Issues range from satisfying rising demand to minimizing environmental impacts of energy production.

The Sustainable Energy Engineering (SUSEE) program is an interdisciplinary program jointly offered by the departments of Chemical and Biological Engineering, Civil and Environmental Engineering, Electronic and Computer Engineering, and Mechanical and Aerospace Engineering at HKUST. It focuses on energy generation, transportation, storage, conversion, optimization and management.

With the first batch of graduates in 2021, the SUSEE program was a fairly recent initiative of the University to nurture leading professionals capable of designing and implementing both traditional and renewable energy systems to counter global energy challenges.

WHY SUSEE?

"It is impossible to think of a world without energy. SUSEE has equipped me, a recent graduate, with insights from different perspectives to tackle engineering issues. I have learned that we should not only consider how an issue could be solved, but also how to tackle it in a sustainable way."

– Ms. Yik Sze LAM, Class of 2021

Opportunities as a SUSEE Student / Graduate

Students have opportunities to practice the principles learned in a specially designed SUSEE lab course, and participate in research projects, field trips, internships, and industrial training.

International exchange, competitions and other exciting opportunities are also offered by the School and departments to SUSEE students.

SUSEE graduates may seek employment in government departments, local and international engineering industries, consulting firms, and postgraduate programs.

International Opportunities at a Glance

"During my studies as an undergraduate student, I had the opportunity to participate in the overseas Orlando Chem-E-Car Competition to design and construct a car that was powered by a self-made battery. I was able to compete at the international level with university students from other parts of the world. It was an invaluable experience via which I learned how to work in a team with fellow students from diverse backgrounds as I became open to new ideas and different opinions."

– Ms. Wai Kwan LIU, Class of 2021
Currently HKUST MPhil (CBE) Student

SUSEE & Workplace

"As an Assistant Engineer in the Environmental Engineering Department of REC Engineering, I work on projects focusing on wastewater management and treatment in close collaboration with the HKSAR's Drainage Services Department.

As a SUSEE graduate, I have been using my knowledge and contributing to my company's initiatives towards green solutions, including the installations of a new hydro turbine system at Stonecutters Island Sewage Treatment Works and combined heat-and-power generating sets in various locations in Hong Kong."

– Mr. Chung Li Adam CHAN, Class of 2022
Currently Assistant Engineer at REC Engineering

SUSEE & Workplace

"My current position falls under the Hong Kong Institution of Engineer's Scheme A Accreditation. It is a two-year training program that provides structured development including stretch roles and diverse job rotational opportunities, mentorship, technical and soft skills training, and innovative projects.

At SUSEE, I had the freedom to choose topics of my interest, such as solar energy, energy storage and carbon footprint analysis. These topics are of high relevance to any forward-looking energy company that has strong awareness of carbon footprint and that invests in renewable technologies."

– Ms. Wing Yi CHENG, Class of 2022
Currently Graduate Trainee (Energy Track) at CLP Holdings Limited

SUSEE & Future Studies

"My undergraduate research was about optimization of proton exchange membrane fuel cell performance. Thanks to SUSEE, I was provided with numerous opportunities to explore my fields of interest, among which hydrogen-related topics were my top priorities. Graduating from SUSEE, I was able to build strong foundations for my postgraduate studies in the field of hydrogen storage.

It is very clear to every SUSEE graduate that clean energies and their complementary technologies such as batteries, fuel cells and energy storage serve irreplaceable roles as businesses and industries move towards a net zero carbon future. This was precisely the reason why I decided to further my studies in the field.

It had been a challenging yet fruitful journey for me as a postgraduate student as I conducted research on potential liquid organic hydrogen carriers. Despite the hurdles and difficulties, I had been given the opportunity to transform inspirations and imaginations into reality with the support from my supervisor Prof. Minhua SHAO."

– Ms. Wai Kwan LIU, Class of 2021
Currently HKUST MPhil (CBE) Student

Student Achievement

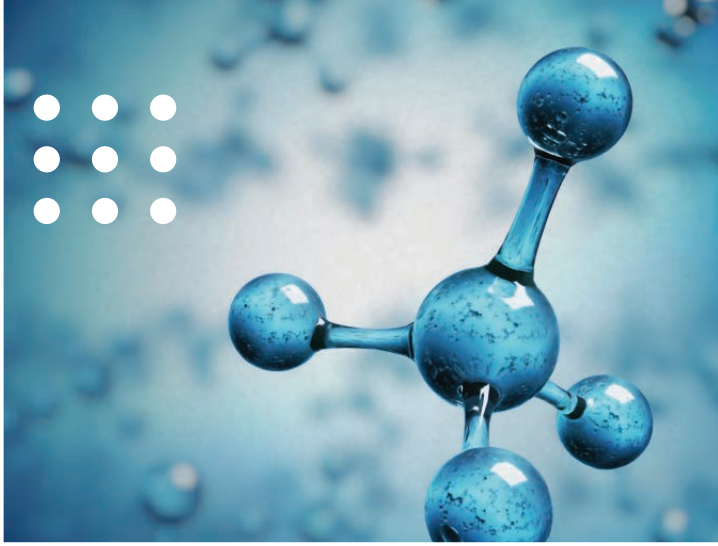
Usman Bin SHAHID won the People's Choice Award at 2021 Asia-Pacific 3MT® Competition

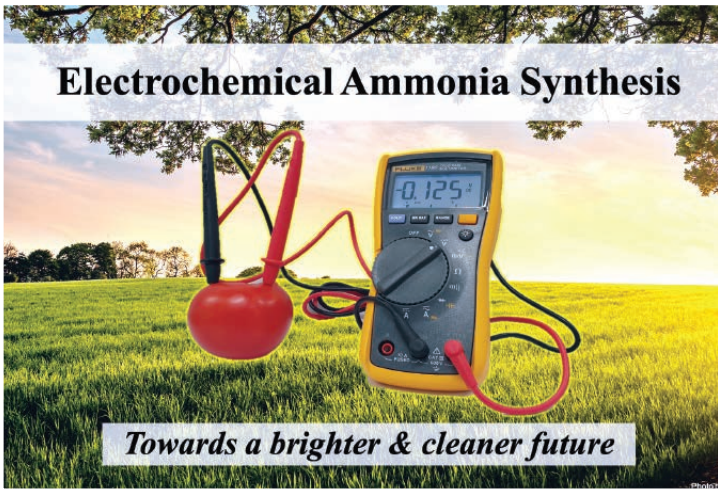
"An 80,000-word thesis would take nine hours to present. Your time limit now ……is 3 minutes." This is what the Three Minute Thesis (3MT®) Competition is all about. On October 20, 2021, HKUST PhD student Usman Bin SHAHID entered the final round of the 2021 Asia-Pacific 3MT® Competition as one of the eight finalists. Usman, two-time runner-up of the HKUST 3MT® Competition, a Chemical and Biological Engineering PhD student under the supervision of Prof. Minhua SHAO and an engineering researcher, impressed the audience with his 3MT® presentation "Electrochemical Ammonia Synthesis: Towards a Brighter and Cleaner Future".

Developed by the University of Queensland, 3MT® is a research communication competition that cultivates students' academic, presentation, and research communication skills and increases their capacity to effectively explain their research in three minutes in a language appropriate to a non-specialist audience. The eight finalists in 2021 were selected among 54 competitors from 54 universities in Australia, New Zealand, Northeast Asia, Oceania, and Southeast Asia.

"Your audience could be anyone, literally anyone from an eight-year-old kid to an 80-year-old academician, who was able to understand your research successfully," recalled Usman who always had his audience in mind. After the competition that lasted for one-and-a-half hours, Usman won the People's Choice Award at the 2021 Asia-Pacific 3MT® Competition. Not only did he become the first HKUST student who entered the final round of this competition. He was also the first student from a university in Hong Kong that was awarded by the Asia-Pacific 3MT® Competition since its launch in 2010 (formerly known as Trans-Tasman 3MT® Competition prior to 2016).

When asked how 3MT® had benefited him, Usman responded, "I initially thought that 3MT® required you to trivialize your research so that people could understand it better. Now as a participant however, I realized that was definitely not the case. In fact, the Competition helped me put into perspective three very important aspects: *Why? What? How?* A simple answer to these three questions is what 3MT® is all about. That is what helped me realize the purpose of my PhD and maintain focus all these years."





Prof. Ping GAO and Dr. Qi'ao GU's Team Won Top Award at International Exhibition of Inventions of Geneva 2022

The International Exhibition of Inventions of Geneva 2022 was held in late March. By March 28, all participants except the team led by Prof. Ping GAO, a researcher specializing in polymer materials, and Dr. Qi'ao GU at HKUST, had been notified of the results.

"With all the work we have put into, don't we deserve an award even if it is not a Special Merit Award?" Dr. Qi'ao Gu, a member of Prof. Gao's team recalled. "I could not help but send an email to the organizers and ask about the results. When they replied with congratulations and told us that we won the Special Merit Award, a top award, I burst with joy," he added.

Founded in 1973, the International Exhibition of Inventions of Geneva is a large-scale international exhibition sponsored by the Swiss Federal Government and the Municipal Government of Geneva. It is also one of the earliest and largest events exclusively devoted to exhibitions around the world.

Prof. Ping Gao and Dr. Qi'ao Gu won the Gold Medal with Congratulations of the Jury with the program titled "The Synthesis Method of Flexible Multi-functional Ultra-thin Polyethylene Membrane with High Porosity". Whereas a report by the World Intellectual Property Organization (WIPO) stated that China's technological dependence on the United States in the field of polymer materials ranks third among all fields, the HKUST team's latest award demonstrates what the country can do without relying on other countries.

Together with other members, Prof. Gao has spent more than 10 years developing an ultra-thin nanomembrane, which is not only ultra-thin (only 1/5000 as thick as a human hair) but is also considered to be the strongest polymer nanomembrane in the world. The nanomembrane is extremely transparent, gas-permeable and water-proof with adjustable porous properties. This makes it suitable for use as wearable devices, medical protection, desalination, electronics, solar cells and many other cutting-edge technologies.

Prior to this, Dr. Qi'ao Gu had also received the Final Bronze Award at the first National Postdoctoral Innovation and Entrepreneurship Competition 2021. Together with teammates from other disciplines, he had won two entrepreneurship competitions: The 7th China International College Students' 'Internet+' Innovation and Entrepreneurship Competition 2021 – Gold award, and the 7th Hong Kong University Student Innovation and Entrepreneurship Competition 2021 – First Prize (Entrepreneurship Proposal Track).

Prof. Ping Gao (second left), her PhD student Qi'ao Gu (second right), as well as Shu Kwan Cheung (first left) and Walter Lee (first right) from Design and Manufacturing Services Facility of HKUST

Polymer nanofilm developed by Prof. Gao's research team

Congratulations to our students who have received numerous awards and honors!

(The list of awards below shows some of our student awards. It is not exhaustive.)

Usman Bin SHAHID	• People's Choice Award in the 2021 Asia-Pacific Three Minute Thesis (3MT®) Competition
Shane Rayhan D'SOUZA **Woo Won SHIM** **Kyu Won SHIM** **Mohammed AANAS**	• AIChE Chemical Engineering for Good Challenge (ACE4G) 2021: 2nd Place
Qi'ao GU	• International Exhibition of Inventions of Geneva 2022: Gold Medal with Congratulations of the Jury • The first National Postdoctoral Innovation and Entrepreneurship Competition 2021: Final Bronze Award • The 7th China International College Students' 'Internet+' Innovation and Entrepreneurship Competition 2021: Gold Award • The 7th Hong Kong University Student Innovation and Entrepreneurship Competition 2021: First Prize (Entrepreneurship Proposal Track)
Xiangrong LI **Tsz Wing TANG** **Woo Won SHIM** **Shane Rayhan D'SOUZA** **Mohammed AANAS** **Kyu Won SHIM**	• HKIE/SSC Students Project Competition 2021: Group B: Master - Merit
Ming Hong CHEUNG **Siu Kan CHU** **Jingmin DONG** **Cheuk Nam FOK** **Chun Kit WONG**	• BSOMES (Building Services Operation and Maintenance Executives Society) Research Prize 2021: Group Awards - 1st Prize
Ka Lun NG **Siu Ting LEUNG** **Kwan Ho KWOK** **Tin Yiu NG**	• BSOMES (Building Services Operation and Maintenance Executives Society) Research Prize 2021: Group Awards - 2nd Prize
Yanke LIN **Yian WANG** **Jixizng YANG** **Leicheng ZHANG**	• HKUST RedBird Academic Excellence Award for Continuing PhD Students 2021/22
Fei XIAO	• Chan Tak Kei & Wong Kwai Ying Best PG Award for Excellent Research 2021
Kumar SIDDHARTH	• Best PG Award for Excellent Research of the Chemical and Biological Engineering Department 2021

New Members

HKUST has a wealth of expertise in energy comprising top-notch scholars at the frontiers of energy-related research. As part of the university-wide initiative to promote energy research and education, the Energy Institute (EI) brings together innovative, world-class scientists from a wide range of disciplines. In the past year, 15 new members joined the EI family.

Furong GAO

Chair Professor of Chemical and Biological Engineering

Research Area
- Energy storage and distribution

Research Interests
- Advanced materials
- Battery thermal management
- Product and process systems engineering – process monitoring, control and optimization
- Injection molding
- Smart manufacturing and big data

Masaru YARIME

Associate Professor of Public Policy

Research Area
- Energy policy

Research Interests
- Science, technology, and innovation policy
- Policy for sustainable energy transitions
- Governance of data-driven innovation
- Innovation for sustainable smart cities
- Climate change and the circular economy

Ye QI

Professor of Public Policy

Research Area
- Energy policy

Research Interests
- Chinese environmental and energy policy
- Environmental policy and governance
- Climate change and global environmental governance
- Sustainability science and governance
- Sustainable urbanization

Laurence Laurencio DELINA

Assistant Professor of Environment and Sustainability

Research Area
- Energy Policy

Research Interests
- Policy evaluations
- Renewable energy
- Environmental sustainability
- Accelerating just energy transitions

Jinglei YANG

Professor of Mechanical and Aerospace Engineering

Research Area
- Energy utilization and conservation

Research Interests
- Multifunctional materials for sustainable energy
- Composite materials and science
- Interface science

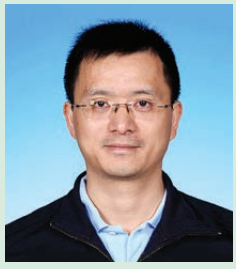
Jonathan Eugene HALPERT

Assistant Professor of Chemistry

Research Area
- Energy generation

Research Interests
- Synthesis of nanocrystals and nanostructured materials
- Solar cells and solar fuels
- Energy materials for generation and storage
- Quantum dot and perovskite light emitting devices (LEDs)
- Optoelectronic devices

Tom Zhengtang LUO



Associate Professor of Chemical and Biological Engineering

Research Area
- Energy utilization and conservation

Research Interests
- Advanced materials
- Graphene chemistry and physics
- Functional polymer

Yoonseob KIM

Assistant Professor of Chemical and Biological Engineering

Research Area
- Energy storage and distribution

Research Interests
- Porous and crystalline polymers
- All-solid-state Li-based batteries
- Electrochemical energy generation
- Advanced materials

Magdalena KLEMUN

Assistant Professor of Public Policy

Research Area
- Energy policy

Research Interests
- Techno-economic modeling
- Energy systems analysis
- Technology evolution
- Low-carbon innovation
- Energy and climate policy

Mitch Guijun LI

Assistant Professor of Integrative Systems and Design
Assistant Professor of Electronic and Computer Engineering

Research Area
- Energy generation
- Energy utilization and conservation

Research Interests
- Advanced manufacturing

Haipeng LU

Assistant Professor of Chemistry

Research Area
- Energy generation

Research Interests
- Advanced materials
- Energy conversion
- Catalysis
- Nanomaterials

Stephane REDONNET

Assistant Professor of Mechanical and Aerospace Engineering

Research Area
- Energy generation

Research Interests
- Practical application to aerospace and energy sectors (aircraft, drones, wind turbines, etc.)
- Numerical simulation in aero-acoustics (highly accurate and hybrid methods, large scale computing)
- Fundamental investigation of flow and noise physics (passive and active flow control)
- Conceptual exploration of low emission technologies (chemical and acoustical)

Yanguang ZHOU

Assistant Professor of Mechanical and Aerospace Engineering

Research Area
- Energy generation
- Energy utilization and conservation

Research Interests
- Green energy technologies
- Algorithm development on nanoscale heat transfer
- Quantifying heat transport at the interfaces via experiments and simulations

Frank LAM

Assistant Professor of Engineering Education

Research Area
- Energy generation
- Energy storage and distribution

Research Interests
- Catalysis
- Electrocatalysis
- Environmental pollution treatment
- Nanotechnology

Jingjie GE

Research Assistant Professor of Chemical and Biological Engineering

Research Area
- Energy generation
- Energy storage and distribution

Research Interests
- Advanced materials
- Nanomaterials science and engineering
- Green energy production and conversion
- Single-atom catalysis

Faculty Achievement

Prof. Ding PAN Named 2021 Emerging Leader

Prof. Ding PAN, Associate Professor of Chemistry and Physics, was named one of the 2021 Emerging Leaders by the *Journal of Physics D: Applied Physics* in the UK. Emerging leaders are top researchers in their fields who have completed PhD 10 years prior to invitation. They have been identified by the Editorial Board and the applied physics community as the most outstanding researchers in the generation.

Prof. Pan works with hydrocarbons and Raman Spectroscopy. Hydrocarbons are of great importance to carbon-bearing fluids in Deep Earth and ice giant planets at extreme pressure (P)–temperature (T) conditions. Raman Spectroscopy is a powerful tool to study the chemical speciation of hydrocarbons. It is, however, challenging to interpret Raman data at extreme conditions. Prof. Pan's team studied the pressure and temperature effects on the Raman bands and identified the characteristic Raman modes for the C–C and C–C–C bonds. Their results help with the interpretation of in situ Raman data of hydrocarbons at extreme P–T conditions, with important implications for studying hydrocarbon reactions in the deep carbon cycle inside the Earth and the composition of ice giant planets. Their paper "Raman Spectra of Hydrocarbons under Extreme Conditions of Pressure and Temperature: a First Principles Study" has been published in the *Special Issue: Emerging Leaders of the Journal of Physics D: Applied Physics.*

In appreciation of Prof. Pan's exceptional achievements in research, HKUST's School of Science awarded him the 2022 School of Science Research Award. He is currently developing and applying computational and numerical methods to understand and predict the properties and behavior of liquids, solids, and nanostructures from first principles. In so doing, he thrives to seek answers to the urgent and fundamental scientific questions relevant to sustainable development, such as water science, deep carbon cycle, and clean energy. His recent research contributes to understanding of physical and chemical properties of carbon bearing aqueous fluids in conditions of extreme pressure and temperature, which are of great importance to the Earth's carbon cycle.

Prof. Pan obtained BSc in Physics at the University of Science and Technology of China in 2005, followed by ScD (Doctor of Science) at Institute of Physics, Chinese Academy of Sciences in 2011. During ScD studies, he was a visiting researcher at the Fritz Haber Institute of the Max Planck Society in Berlin, Germany and a Thomas Young Centre Junior Research Fellow at the University College London in the UK. Before joining HKUST in 2016, he served as a postdoctoral researcher in the University of California, Davis from 2011 to 2014 and the University of Chicago from 2014 to 2016. Since he joined HKUST, his achievements have been recognized by local and international scientific communities, with awards ranging from Croucher Innovation Award 2018 in Hong Kong, Deep Carbon Observatory Emerging Leader Award 2019 by Alfred P Sloan Foundation in the US, to excellent Young Scientists Fund 2020 (Hong Kong and Macau) by the Natural Science Foundation of China.

Prof. Zhiyong FAN Awarded Xplorer Prize 2022

Faculty of the Energy Institute Prof. Zhiyong FAN, Professor of Electronic and Computer Engineering as well as Chemical and Biological Engineering, was named an awardee of the Xplorer Prize 2022 in the field of advanced interdisciplinary studies. Supported by Tencent Foundation, the award encourages young scientists aged 45 or below in Mainland China, Hong Kong, and Macau to research unexplored areas of basic sciences and frontier technologies. Prof. Fan is one of the only two recipients from Hong Kong among 50 awardees from 10 fields this year. Each awardee will receive RMB 3 million over a period of five years, which is among the highest in talent funding programs for young scientists in China.

The Xplorer Prize was initiated in 2018 by Pony MA, Chairman and Chief Executive Officer of Tencent and Founder of the Tencent Foundation, alongside 14 renowned scientists including Yi RAO, Chen-Ning YANG, Shude MAO, Huawu HE, Hequan WU, Peigen LI, etc. It has funded over 200 promising young scientists in the past four years. Assessment criteria include candidates' academic achievements and research proposals, with a focus on independence, exploration, creativity, innovation, and feasibility.

Prof. Fan joined HKUST in 2010 after completing PhD studies in the University of California, Irvine and postdoctoral research in the University of California, Berkeley. Over the past years, he has quickly established himself as a renowned scientist with international reputation in nanomaterials, nanoelectronics and optoelectronics with exceptional achievements in academic research in terms of journal publications, research grants, and postgraduate student supervision. His research focuses on rational design and fabrication of nanostructures, basic understanding of their physical and chemical properties and the utilization of these materials for electronic and optoelectronic device applications. These devices include solar cells, photodetectors, light-emitting diodes and various types of sensors. Highly interdisciplinary in nature, his research involves electrical engineering, materials science and engineering, chemistry, and physics.

In his high-powered academic career, Prof. Fan has published over 220 research papers in top journals, including *Nature, Nature Photonics, Nature Communications, Science Advances, Advanced Materials, ACS Nano,* and *Nano Letters,* with over 24,000 citations and an h-index of 81. His multiple recognitions to date range from Fellow of the Royal Society of Chemistry, Highly Cited Researcher by Clarivate Analytics, HKUST School of Engineering's Young Investigator Award and Research Excellence Award, to HKUST-Sino One Million Dollar Entrepreneurship Competition's President Award and Innovation Award. He is also a founding member of the Hong Kong Young Academy of Sciences.

Prof. Fan has been active in seeking external funding support. With this latest funding, he has secured more than HK$23 million in research grants from Hong Kong and Mainland China since 2010.

Prof. Minhua SHAO Named International Outstanding Young Chemical Engineer 2022

Prof. Minhua SHAO, Director of HKUST's Energy Institute, received the International Outstanding Young Chemical Engineer Award (2022) in the Global Chinese Chemical Engineer Symposium held in Guangzhou on August 12-15, 2022.

The International Award for Outstanding Young Chemical Engineer is established, selected and delivered jointly by the Chemical Industry and Engineering Society of China (CIESC) and Global Academy of Chinese Chemical Engineers (GACCE). It is an international award aiming to encourage young chemical engineers to devote themselves to the chemical industry, enhance innovation and application capabilities, promote learning and exchange of chemical engineers at home and abroad, and strengthen the selection and cultivation of talent reserve for international organizations. It awards young engineers from around the world who have made outstanding contributions to scientific research and innovation, and to international exchange and cooperation in chemical industry.

Prof. Minhua Shao graduated from Xiamen University with a Bachelor's degree and a Master's degree in Chemistry in 1999 and 2002 respectively. After completing PhD in Materials Science and Engineering from Stony Brook University, he joined UTC Power in 2007, leading a collaborative project with Toyota Motor Company to develop fuel cell technologies. He was promoted several times at UTC Power and finally achieved Technical Fellow status, the highest engineering rank, owing to his excellent technical contributions, leadership and mentoring skills. It is worth noting that he was the youngest person to achieve Fellow status in the history of UTC (now Raytheon Technologies). In 2013, he joined Ford Motor Company to conduct research on lithium-ion batteries as a senior battery engineer.

Prof. Shao joined HKUST in 2014 as an Associate Professor in the Department of Chemical and Biological Engineering. He was then substantiated in June 2017, and promoted to Professor in June 2019, Chair Professor in June 2022, and the Cheong Ying Chan Professor of Energy Engineering and Environment in September 2022.

Prof. Shao is a world-renowned electrochemist. His main research interests focus on electrochemical energy conversion and storage technologies, such as fuel cells, secondary batteries, and electrolyzers. He has published 230 peer-reviewed papers with over 21,000 citations (Google Scholar) with an H factor of 65, and one edited book. One single paper (*Chem. Rev.* 2016) has been cited over 2,800 times and ranked #5 as the most cited paper authored by Chinese and published during 2009-2019. He was ranked #2703 in the World's Top 2% Scientists List released by Stanford University in 2022. He has also filed over 30 international patent applications (18 issued) on fuel cells, electrolyzers and batteries, many of which have been licensed to automotive and fuel cell companies. He is one of the founding members of Young Academy of Science of Hong Kong and its Honorary Secretary since 2021, an Associate Editor of *Journal of the Electrochemical Society* since 2017, and Editorial Board Member of other six peer-reviewed journals. He is currently the Vice Chairman of the Hong Kong Fuel Cell and Hydrogen Energy Association, and the secretary of the Energy Technology Division of the Electrochemical Society (ECS). He has also received a number of awards, including the Supramaniam Srinivasan Young Investigator Award from the ECS Energy Technology Division in 2014.

Congratulations to our faculty members who have received numerous honors and accolades!

(The list of awards below shows some of our faculty awards. It is not exhaustive.)

Prof. Minhua Shao

- Director of Energy Institute
- Chair Professor of Chemical and Biological Engineering

- Cheong Ying Chan Professor of Energy Engineering and Environment
- International Outstanding Young Chemical Engineer Award 2022

Prof. Jiannong WANG

- Chair Professor of Physics

- Wu Chien-Shiung Professor of Science
- Fellow of the Physical Society of Hong Kong 2021

Prof. Zhiyong FAN

- Professor of Electronic and Computer Engineering
- Professor of Chemical and Biological Engineering

- Xplorer Prize 2022

Prof. Jianwei SUN

- Professor of Chemistry

- Fellow of the Royal Society of Chemistry 2021

Prof. Henry He YAN

- Professor of Chemistry

- Highly Cited Researcher 2021, Clarivate Analytics

Prof. Jinglei YANG

- Professor of Mechanical and Aerospace Engineering

- Fellow of the Royal Aeronautical Society 2021
- Fellow of the Royal Society of Chemistry 2021

Prof. Ding PAN

- Associate Professor of Chemistry
- Associate Professor of Physics

- 2021 Emerging Leader, *Journal of Physics D: Applied Physics*
- 2022 School of Science Research Award

Prof. Haipeng LU

- Assistant Professor of Chemistry

- 2022 *Nanoscale* Emerging investigator, the Royal Society of Chemistry

Prof. Yoonseob KIM

- Assistant Professor of Chemical and Biological Engineering

- Rising Star, *ACS Materials Au,* American Chemical Society, 2022

Prof. Yanguang ZHOU

- Assistant Professor of Mechanical and Aerospace Engineering

- Emerging Environmental Scientist, Hong Kong SciTech Pioneers Award 2022, the Y-Lot Foundation

Highlighted Research Projects Awarded in 2021-2022

Hong Kong

Funding Agency	Leading Faculty	Project
Green Tech Fund	Francesco CIUCCI	Green Hydrogen Production from Active Flow Membraneless Elecrolyzers
	Minhua SHAO	Development of High Performance and Long Life Hydrogen Fuel Cells Stacks
Collaborative Research Fund	Minhua SHAO	Development of High-Performance and Long-Life Alkaline Membrane Fuel Cells
	Jianwei SUN	Development of a New Generation of Privileged Chiral Catalysts for Asymmetric Synthesis
Research Impact Fund	Tianshou ZHAO	Development of Safe and Energy-Dense All-Solid-State Lithium Batteries
Innovation and Technology Fund	Xijun HU	Development of a Comprehensive System for Transforming Soybean Waste to High Quality Activated Carbon and its Associated Wastewater Remediation
	Mitch Guijun LI	Performance Control and Microstructure Analysis of Clay Mineral-based Cathode Materials for Lithium-sulfur Batteries
	Minhua SHAO	Development of Electrocatalysts for Water Splitting with High Current Density and Durability
		Development of Key Materials for Long-Life All Solid Lithium Metal Batteries
		Development of Advanced Nickel-Rich Layered Cathode Materials for Lithium-Ion Batteries
	Jinglei YANG	Development of Direct Microencapsulation of Amine Curing Agents to Formulate One-part Epoxy Adhesives

Mainland

Funding Agency	Leading Faculty	Project
Beijing Institute of Collaborative Innovation	Jiannong WANG	Development of GaN Heterostructure UV Photodetector Integrated Circuits
Nanhai People's Government of Foshan	Zhiyong FAN Baoling HUANG	Research and Industrialization of Flexible and Wearable Intelligent Environment Sensing Systems Driven by High Safety Hydrogel-based Battery for Special Industries

Community Engagement

Energy Institute participated in EMSD Symposium

Three professors from HKUST Energy Institute (EI) were invited to share insights at the EMSD Symposium organized by HKSAR's Electrical and Mechanical Services Department (EMSD) in Jan 2022 with the theme "C0-innovinity" which was inspired by Carbon Net-Zero, Innovation and Infinity.

Prof. Francesco CIUCCI, EI faculty and Associate Professor of Mechanical and Aerospace Engineering, was invited to give a presentation on "Emerging Technologies for Carbon Neutrality: Solid state Batteries for Electric Vehicles and Electrolysis for Green Hydrogen Production".

At the Symposium, EI faculty Prof. Yi-Kuen LEE's team demonstrated their project "Wireless Multi-Sensor System for Smart Energy-Efficient Buildings Using TSMC 0.18μm CMOS MEMS Technology". Prof. Tianshou ZHAO's team shared their project "Advanced Vanadium Redox Flow Battery for Scalable Storage of Renewable Energies".

The one-day event aimed to provide a platform for around 450 local and overseas experts from governments, institutions, consulting firms, universities, trade associations, environmental groups and other concerned parties to share experience on technologies, create ideas, stimulate innovations and explore E&M engineering solutions and energy-saving regulations for a smarter, safer and greener Hong Kong.

Community Enagement

HKUST-UoS-CLP joint Workshop on Energy Decarbonisation

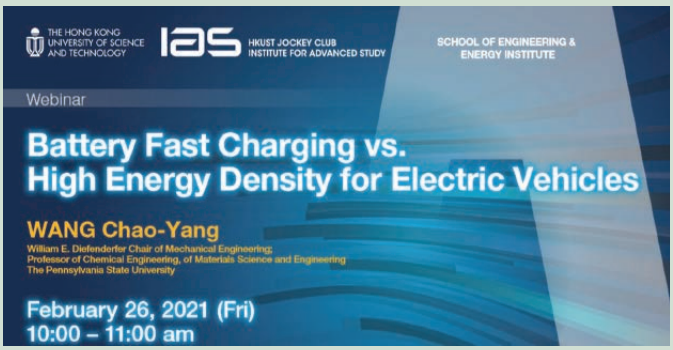
Decarbonisation, essential for clean and sustainable energy, is a critical step towards achieving livable climate and future. Transition to clean energy and the creation of a prosperous future relies on viable and innovative decarbonising technologies. To promote decarbonisation and research collaborations, address the issues and explore potential directions, HKUST joined hands with the University of Strathclyde (UoS) and CLP to co-organize an online workshop in March 2021.

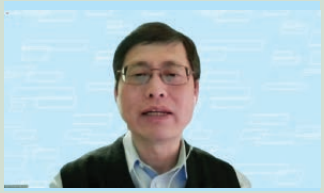
Distinguished keynote speakers Mr. Philippe JOUBERT, former Deputy CEO of Alstom, shared on “Energy Decarbonisation”: the Case of Power”. Ms. Gina DOMANIG, Managing Partner of Emerald Technology Ventures, talked about “What Emerald is Seeking in Startups…”.

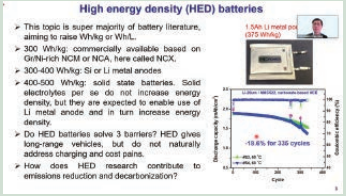
Prominent scientists from both universities and CLP shared experience and insights on decarbonised future. The event attracted over 400 faculty members, students, and staff from universities, industrial partners and government departments from Hong Kong and the UK.

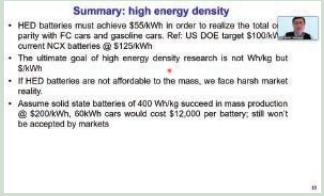
IAS-EI joint webinar on Battery Fast Charging vs. High Energy Density for Electric Vehicles by Prof. Chao-Yang WANG

Prof. Chao-Yang WANG, William E. Diefenderfer Chair Professor of Mechanical, Chemical Engineering, and Materials Science and Engineering at the Pennsylvania State University, gave an online presentation on “Battery Fast Charging vs. High Energy Density for Electric Vechicles” in February 2021. In this lecture, Prof. Wang compared two battery approaches currently under intensive pursuit to eliminate “range anxiety” for electric vehicles (EVs): fast charging and high energy density. He further discussed why any fast charging solutions for EVs must be evaluated under three metrics simultaneously: charge time (<10 min), specific energy acquired by fast charge (>180 Wh/kg), and cycle number (>1000) under the fast charge condition.









香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

能源研究院
ENERGY INSTITUTE

Committee

Advisory Committee

Chairman
Prof. Bert SHI
Acting Dean of Engineering, HKUST

Members
Ir. Simon Siu Hing NGO
Head of Engineering – Hong Kong Utilities Towngas

Dr. Stephen Chuying OUYANG
Co-President of Research and Development
Executive Deputy Director of 21C LAB
Contemporary Amperex Technology Co., Limited (CATL)

Ir. Prof. Paul POON
Vice Chancellor, CLP Power Academy
CLP Power Hong Kong Limited

Prof. Chao-Yang WANG
William E. Diefenderfer Chair Professor of Mechanical, Chemical Engineering, and Materials Science and Engineering
Pennsylvania State University

Prof. Minhua SHAO
Director of HKUST Energy Institute
Cheong Ying Chan Professor of Energy Engineering and Environment
Chair Professor of Chemical and Biological Engineering, HKUST

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Prof. Tianshou ZHAO
Founding Director of HKUST Energy Institute
Chair Professor of Mechanical and Aerospace Engineering, HKUST

Prof. Zhiyong FAN
Professor of Electronic and Computer Engineering
Professor of Chemical and Biological Engineering, HKUST

Prof. Baoling HUANG
Professor of Mechanical and Aerospace Engineering, HKUST

Prof. Qing CHEN
Associate Professor of Mechanical and Aerospace Engineering
Associate Professor of Chemistry, HKUST

Prof. Ding PAN
Associate Professor of Physics
Associate Professor of Chemistry, HKUST